Simulation and measurement of bacterial growth on low soluble phenanthrene substrate

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TU228 Simulation and measurement of bacterial growth on low soluble phenanthrene substrate S. Trapp, Danmark Tekniske Universitet / DTU Environment; I. Adam, Helmholtz Center UFZ Leipzig / Envmental Biotechnology; A. Rein, TU Munich; A. Miltner, Helmholtz Center UFZ / Environmental Biotechnology; A. daCostaFulgencio, Helmholtz Center UFZ; M. Kaestner, Helmholtz Centre for Environmental Research UFZ / Dept Environmental Biotechnology. The metabolism of low soluble substrate is limited by dissolution and substrate availability and can hardly be determined in a common chemostat. We developed a numerical model that calculates simultaneously dissolution kinetics of such substrate, metabolism (Michaelis-Menten kinetics) and microbial growth (Monod kinetics with decay term) for the dynamic case. Experiments on the degradation of phenanthrene by and the growth of the three degrader strains *Novosphingobium pentaromativorans* US6-1, *Sphingomonas* sp. EPA505 and *Sphingobium yanoikuyae* B1 were used to determine kinetic parameters as input for the model. Phenanthrene (Pht) in acetone was added to 10 mL test vials. The nominal initial concentration of the suspensions was 10, 25, 50, 100, 200 and 400 mg/L. Pht was present as slowly dissolving microcrystals. This provided non-limiting conditions for the growth of the degrader strains over several days. Total Pht concentration and protein were tracked over 6 to 12 days. In all replicates, Pht was completely metabolized, and biomass increased rapidly, more at higher initial concentration, but decayed when Pht was depleted. The model was fitted to the test result in order to determine the rates of dissolution, metabolism and growth. The outcome shows that the three bacterial strains have similar efficiency, with vmax-values of 12 to 18 g bacteria dw / g substrate / d, yields of 0.21 g/g, maximum growth rates umax of 2.5 to 3.8 1/d and decay rates of 0.04 to 0.05 1/d. Simulations with the model show that i) retainment in crystals, NAPL or by sequestration compete with biodegradation, since molecules remaining non-dissolved cannot be degraded; ii) the conditions for bacterial growth (i.e. dissolution flux and resulting chemical activity of substrate) are more relevant for the final state of the system (both concerning number of degraders and time-course of substrate concentrations) than initial biomass; and iii) the desorption flux regulates the turnover when the substrate source is in solid state or present in sequestered (aged) systems. Provided the equations describe correctly the kinetics, the calibrated model can be used to simulate bioavailability, biodegradation, persistence and treatment options in real systems, such as PAH-contaminated soils.